Identifying tradeoffs between agro-economics and water resources to guide future management decisions

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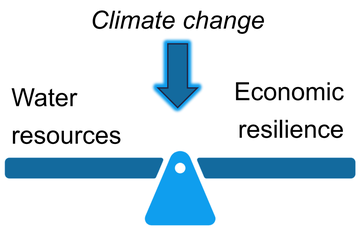
Preliminary study highlights

- Under historical conditions, optimal years tend to be drier, with soybean & corn dominating cultivated land use
- Under preliminary future scenarios, diversified expansion & rainfed management scenarios maintain net returns while minimally impacting water resources
- **We want to hear from you!** Scan QR code to provide feedback on trade-offs we should consider and objectives we should prioritize!

Motivation

Considering climate risks facing the Eastern KS River Basin and larger Great Plains, we are motivated to identify water and nutrient management strategies to enhance crop productivity, protect water quantity/quality, and sustain agricultural communities.



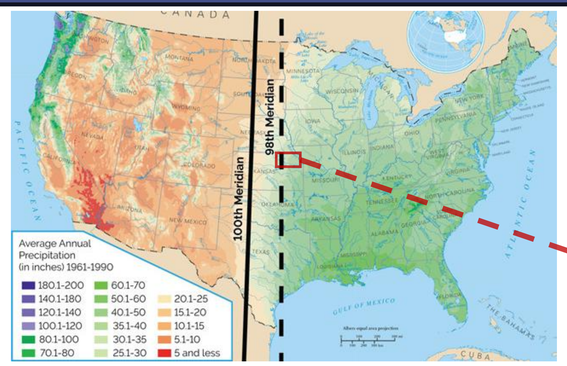
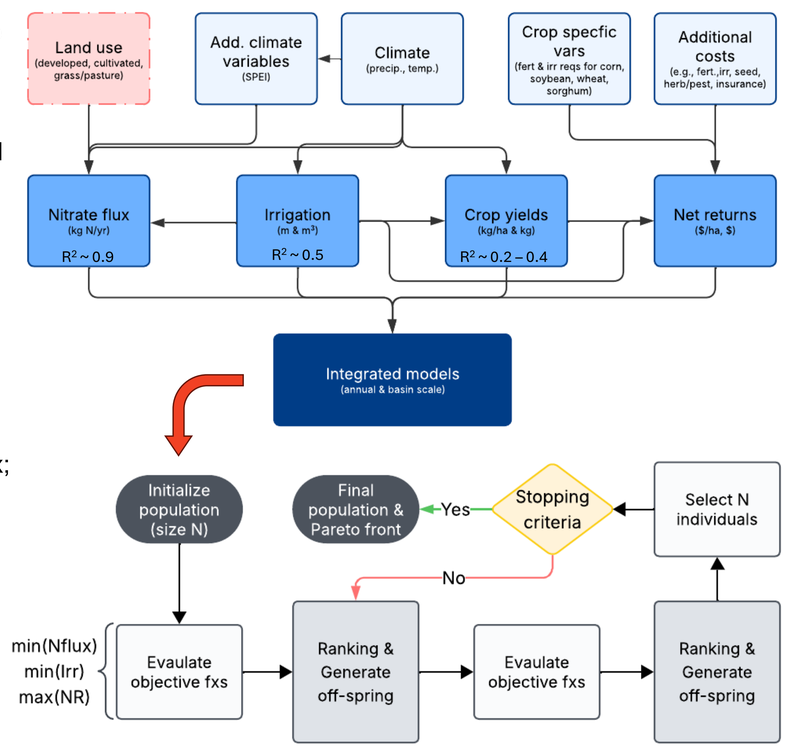


Figure 1. Predicted shift in dividing line between western (arid) and eastern (humid) U.S (*top; National Atlas, K. Cantner, AGI*). The Eastern KS River Basin (red square) is a useful analog for areas that may experience increasing aridity in the 21st century. Current land use in the Eastern KS River Basin (*right*).

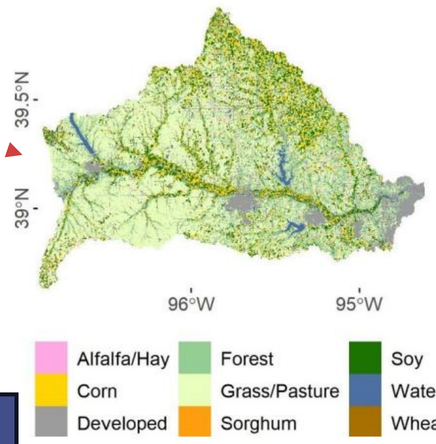
Approach

1. Using existing data from 2006-2024 in the Eastern KS River Basin, we developed & integrated independent statistical models →
2. We used an optimization algorithm (NSGA-II), set land use as the decision variable and identified tradeoffs between:
   - net returns (*maximize*)
   - water quality (N flux; *minimize*)
   - water quantity (irrigation amount; *minimize*) →
3. We assessed outputs to identify tradeoffs in water resources and net returns under alternate scenarios.



Q1: What land use & climatic conditions minimized trade-offs between net returns & water resources historically?

Eastern Kansas River Basin:



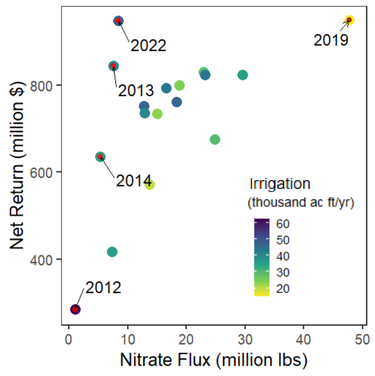


Figure 2. Net returns, nitrate flux, and Irr. from 2006-2024 (*above*). Red points highlight Pareto frontier (trade-offs). Climate from 2006-2024, with Pareto years in red (*top right*). Land use at mid point with min/max shown (*bottom right*).

Q2: What alternate land use scenarios minimize trade-offs?

We considered 4 alternate land use scenarios:

1. Business as usual (BAU)
   - crop types varied +15% (favored grassland >> urban)
2. Irrigated management
   - Prioritized irrigated crops (corn & soybean)
3. Rainfed management
   - prioritized rainfed crops (corn, soybean, wheat & sorghum)
4. Diversified expansion
   - capped corn & soybean (50%) & minimums (10%) on wheat & sorghum

Across the scenarios, we compared Pareto frontiers, knee points, and median/ range of objective outputs.

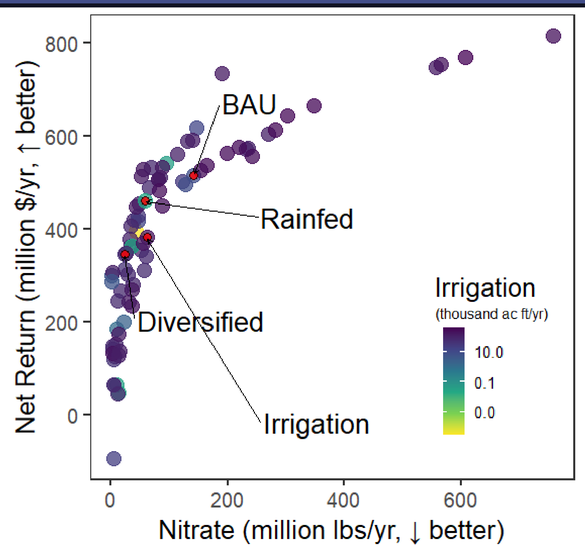
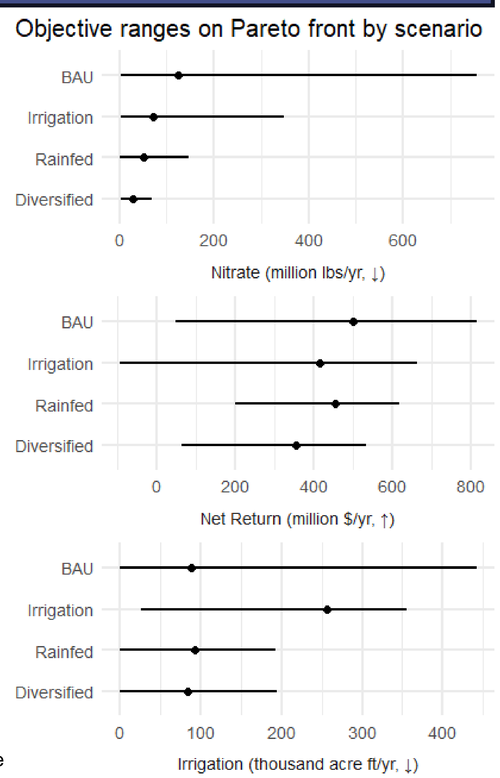


Figure 3. Optimization outputs (Pareto frontiers) from all scenario runs, visualized as water quality (N flux) versus net returns colored by irrigation volume. Red points are the 'knee points' (middle point on frontier; i.e., optimal solution when applying no weights) and labeled by scenario (*top*). Range (line) and median (dot) values of objectives (water quality, net returns, water quantity) over the four scenarios (*right*).



Funding acknowledgement:
This work is supported by the Agriculture and Food Research Initiative, Water Quantity and Quality program, project award no. 2022-67019-37181, from the U.S. Department of Agriculture's National Institute of Food and Agriculture